wise precisely alike. A comparison of these should show whether the foreign object is nearer the dorsal or the plantar aspect of the foot.

"The second point refers to the three objects not seen clearly in the radiogram. The tube used was the ordinary 'shadow of the cross' one, and, though the cross was bent back, the shadow of its supports was visible; two of the objects were directly under this shadow. The third lay parallel and very close to a bone, and hence is not plainly distinguishable."

Photographs have been obtained by utilising other sources of luminosity than high vacuum tubes. The following experiments, performed by Messrs. Wm. Wallace and H. C. Pocklington in the Physical Laboratory of the Leeds Central Higher Grade School, are of interest:—

"A cheap German incandescent lamp of low candle-power was used in place of a Crookes' tube, a piece of tinfoil applied to the outside serving as one electrode, and the filament as the other. The current employed was the high frequency one obtained from a Tesla coil actuated by a large Ruhmkorff. The sparking distance of the Tesla was about 5/8 inch. This apparatus gave a vivid green phosphorescence of the glass, which soon grew less, and in fifteen minutes had almost disappeared. Three exposures were made in succession, each of fifteen minutes: the first when the lamp was new; the second immediately afterwards, the lamp being tired by the previous exposure; for the third, the tinfoil electrode was shifted round about 90°, so as to utilise a fresh part of the surface of the glass. The three negatives were developed simultaneously; the first was good, the other two were under-exposed to about the same extent. In the last experiment, the green phosphorescence, though not as brilliant as in the first, was much more brilliant than in the second. This seems to show that the production of X-rays is due to some cause different from that which produces the phosphorescence."

Mr. J. W. Gifford has obtained photographs by Röntgen's methods, and also by means of the ordinary discharge of an induction coil. Replying to a suggestion that results obtained by him with metal discs were due to a "contact" phenomenon, and not to Röntgen's rays, he says:—

"I notice in your issue of February 13, p. 340, that Mr. Sydney D. Rowland thinks that he has evidence to prove that my results without a Crookes' tube were not due to the 'Röntgen rays.' I have already replied to his observations elsewhere (*British Medical Journal*); but will you allow me to say that I think the evidence he advances entirely turns on whether the electrograph was a shadow or an impression, or, in other words, whether surface markings of the objects electrographed were reproduced, or not. Now, the discs I used bore numbers stamped on them, but in no case were these numbers, or any surface markings whatever, to be found in the resulting negative, a print of which I enclose.

"With regard to what Mr. Rowland says about the objects, in his case, being behind or in front of the film, I would suggest that the discharge from a coil is an oscillatory one, and that glass is fairly transparent to the 'Röntgen rays,' almost as transparent as aluminium, in fact. But conditions are often so different, that I do not feel justified in criticising another man's work without having seen his experiments myself. I must, however, most emphatically disclaim any positive assertions in the present stage of the inquiry. I have, as far as I am aware, only mentioned tentatively what seem to me the general indications of my experiments up to now, and feel that in investigations of this kind the balance is generally in favour of one's first impressions being wrong.

"I do not know if you have observed that when Crookes' tubes are employed for the purpose, after about an hour's use they become coated, both above and below, with a thin layer of dust. This happens, at least, time after time in my own laboratory."

Mr. W. A. D. Rudge, writing from the Science, Art and Technical Schools, Plymouth, says that he has obtained a radiogram of a crayfish, and found the exoskeleton to be as transparent to the new radiations as glass and aluminium.

Our United States correspondent sends us descriptions of work being done in America, in continuation of Röntgen's discovery. He says very successful photographs have now been obtained by Prof. A. W. Wright, of Yale. Prof. Wright has photographed a piece of metal having a fracture which had been welded, but showed no flaw or line of puncture to the eye. The photograph, however, revealed the fracture. This last result was considered by ordnance officials of the Government to be of profound significance, as indicating a means of testing armour for hidden defects and discovering hidden flaws in machinery. Prof. John Trowbridge, of Cambridge, Mass., has also obtained some results. He arranged strips of glass an eighth-inch thick in a wooden box of inch board, and passed the rays through the board, thus obtaining a photograph of the strips of glass. By passing the rays through prisms of wood and of vulcanite he has confirmed the observation that they were not refracted.

THE MANUFACTURE OF ALUMINIUM BY ELECTROLYSIS.

At the ordinary meeting of the Institution of Civil Engineers on Tuesday, February 11, a paper was read on "The Manufacture of Aluminium by Electrolysis, and the Plant at Niagara for its Extraction," by Mr. Alfred E. Hunt. The author's description of the ores of aluminium best fitted for electrolytic reduction to the metallic state, and of the general principles governing the extraction of the metal from its compounds, makes interesting reading.

The Hall process, which is that adopted by the Pittsburg Reduction Company, involves the direct electrolysis of the sesquioxide, alumina, dissolved in a molten bath of the mixed fluorides of aluminium, calcium and sodium. One cubic foot of the solvent serves for an hourly production of one pound of metallic aluminium, the bath used being capable of dissolving one-third of its own weight of alumina. The electrical energy required for extracting this amount of metal is 3730 watt-hours for the decomposition of the alumina, with a further supply to maintain the bath at the temperature necessary for the molten condition. The fluorides remain unchanged, so that the operation is continuous. The bath is made either from a mixture of fluorspar and cryolite, or from the artificial fluorides; and it may be fused in a separate vessel when starting work, or in the bath by the current itself. Alumina is added at frequent intervals to prevent too great a variation in the resistance of the bath, and the aluminium, as it is produced, is siphoned from beneath the layer of fluoride, where it collected, without interference with the progress of the operations. The oxygen of the alumina is liberated at the carbon anode, which, at the temperature of the bath (980° C.) oxidises to carbon monoxide. Outside the bath this is burnt at once to carbon dioxide, and is allowed to escape into the working apartment. The carbon anodes are consumed at nearly the same rate as the aluminium is produced, the amount being about two-thirds of the quantity actually used. The difference of potentials theoretically necessary for the separation of the constituents of alumina is about 2·8 volts, but a greater difference is due to the resistance of the bath. The pots employed are of iron with carbon linings, but these can be dispensed with if a high degree of purity is not required.

The chief impurities in the finished product are silicon and iron. These are derived from the alumina as well as from the carbon anodes. Aluminium can be produced containing 99¾ per cent. of the pure metal, and is regularly delivered with 99 per cent. The electrolytic baths are joined in series, the positive bar of the switch-board being joined to the carbon anode of one of the baths, and the last pot of the series being joined to the negative board of the switch-board. All the copper connections are necessarily very heavy, on account of the large currents employed.

The electrical energy is generated at the works of the Niagara Falls Power Company, and is conveyed, without the intervention of transformers, over a distance of about half a mile, by stranded copper cables 1¼ inches in diameter. The loss in transmission is about 1½ per cent. of the energy conveyed.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—Mr. D. H. Nagel, Fellow of Trinity College, has been elected as a Delegate of Local Examinations in place of Mr. E. Chapman, Fellow of Magdalen College, resigned.

Mr. F. T. Richards, Fellow of Trinity College, has been re-elected a Curator of the Botanic Garden.

Mr. J. E. Marsh, M.A., Balliol College, has been reappointed Lecturer in Materia Medica and Pharmacology for the year 1896.

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Cambridge.—Mr. J. E. Marr, F.R.S., Fellow of St. John's College, has been reappointed University Lecturer in Geology for five years.

The Council of the Senate propose to submit a grace for the appointment of a syndicate to consider what further rights or privileges (if any) should be granted to women students by the University, and in particular whether they should be admissible to degrees.

The Special Board for Biology propose that the arrangement subsisting for the last twenty years between the University and the Zoological Station at Naples should be renewed for a further period of five years. This arrangement secures for University students the use of a table in the laboratory and facilities for research, in consideration of an annual payment to Dr. Dohrn of £100 from the Worts Travelling Scholars Fund.

The Board of Agriculture has made a grant of £650 to the Glasgow and West of Scotland Technical College. The same amount was granted to the College last year.

In Paris the Société de Topographie is making an effort to establish topography as an ordinary subject of instruction, and has published a circular and syllabus for the purpose.

The Russian Government has, says the *British Medical Journal*, assigned an annual grant, equivalent to about £10,000, to the Medical School for Women in St. Petersburg. The city undertakes to provide £2400, and private munificence has raised an endowment fund of £70,000. Preliminary courses are already being given.

The following are among recent appointments abroad: Dr. Eigenbrodt to be Extraordinary Professor of Surgery at Leipzig; Dr. Lenhossék to be Extraordinary Professor of Anatomy at Tubingen; Dr. M. Valsilieff to be Extraordinary Professor of Theoretical Surgery at Warsaw; Dr. Eliza M. Mosher to be Professor of Hygiene in the University of Michigan.

The following announcements are made in *Science*:—Mr. Joseph Bannigan has given 4000 dols. to the Catholic University of America, and has made known his intention to donate for twelve years 4000 dols. a year for library purposes. By the will of the late Mrs. Doyon, the University of Wisconsin has received 5000 dols., the income of which is to be devoted to scholarships for young women. Two scholarships of 2000 dols. each have been presented to Tufts College, one by Mrs. A. B. Perkins, and the other by J. S. and H. N. White.

The disasters of the late war seem to be teaching the Chinese that the traditional attitude of distrust and exclusion of Western civilisation cannot any longer be safely maintained. It may be taken as a sign of the times that the Vice-Regent of Tientsin has entertained a proposal to start a university upon the European model. The university is particularly intended to foster the technical sciences, and will be connected with a preparatory school. Mr. Charles D. Jenney will undertake its direction, and the staff will be partly composed of foreigners. The autumn of this year is to see the opening of the school and university.

The Apprentices' Institution has recently instituted inquiries among a large number of trade societies and workmen's clubs with a view to ascertaining the opinion of working men themselves upon the apprenticeship system. From the standpoint of the advocates of technical education, the results of their enquiry are very satisfactory. A unanimous affirmative was given by all the trades to the questions—Is your Society of opinion that instruction for a number of years in the workshop is essential to the trained mechanic? But especially valuable and significant is the emphatic "No" to the question—Is your Society of opinion that the instruction afforded in the technical schools is sufficient training for a skilled mechanic with apprenticeship? Asked what they think, whether the instruction in technical schools should be given during apprenticeship or before it, the answer was in the large majority of cases "during apprenticeship." Putting side by side with this the remark of Mr. Reynolds, of Manchester, the Chairman of the Directors, and Organising Secretaries for Technical and Secondary Education, at their recent meeting, that the great difficulty the technical schools had to contend with was the want of preparation exhibited by the pupils who present themselves for instruction in the technical schools, it becomes abundantly manifest what policy ought to be pursued by the Technical Instruction Committees throughout the country.

As we recorded in our issue of February 14, 1895, the County Council of Hampshire resolved to devote £6000 of the surplus of the funds available for technical education during the preceding year to general purposes in the county. It would seem that they are not to be deterred from their retrograde policy by the unanimous protests of the various educational papers, for at the quarterly meeting of the Council, held on the 10th inst., a motion was proposed by the Chairman of the Finance Committee—"That the Finance and Technical Education Committees be instructed to meet together and report to the meeting in May 1896, their opinion upon the manner in which the balance remaining after the annual expenditure on technical education has been defrayed, shall be dealt with." It appears that, notwithstanding the transfer of £6000 from the technical education account towards the cost of the county buildings, up to December 31 last, and taking the estimate to the end of March next, there would be a balance of £12,000. Though the Chairman of the Technical Instruction Committee assured the Council there was no prospect of having a large balance to deal with in the future, evidently meaning that the Committee had every need of this money which they were reserving, the motion was put and carried. It would be supposed from an action such as this, that Hampshire is already well supplied with every kind of secondary education; but is it so? At Southampton, which it is true receives *its share* of the whole grant, there are at least two institutions which are in want of assistance. The Hartley Institution, which receives a county grant of only £75 per annum, is badly crippled for want of funds. The Grammar School similarly is greatly in want of help to develop the technical side of its work, and the same condition of things is true in many other of the local centres. In addition to all this, one hears repeatedly of the urgent need of Schools of Forestry in this country, and yet Hampshire, with the New Forest in its midst, has £12,000 for which it has no educational use!

Particulars are tabulated in the *Technical Education Gazette* of the principal scholarships which are awarded in London, giving free education or education at reduced fees—(1) at the public secondary schools; (2) at universities, university colleges, polytechnics, technical institutes, and other places of higher education; (3) at schools of art. The tables are intended to give some idea as to the opportunities that are offered to the inhabitants of London of obtaining education above the elementary grade, either entirely free or at greatly reduced cost. The total number of scholarships tenable at public secondary schools appear to be as follows: Boys—1240 per annum (of which all except 85 may be regarded as actually available for pupils in public elementary schools). Girls—543 per annum (of which all except 8 may be regarded as actually available for pupils in public elementary schools). Total—1783 per annum (of which as many as 1690 are actually available for pupils in public elementary schools). Taking the average number in attendance in public elementary schools (exclusive of infants) as 382,121, it is found that the number of scholarships available per 1000 children in attendance is 4·4, of which 1·5 per 1000 children are provided by the Technical Education Board of the London County Council. The majority of the scholarships tenable at universities, university colleges, polytechnics, and similar institutions, are restricted as regards the school previously attended, but unrestricted so far as residence is concerned, though some are confined to residents within the county of London. No notice is taken of the numerous scholarships and exhibitions offered by university authorities outside London, such as the colleges of Oxford or Cambridge, but an attempt is made to show the facilities for acquiring training of a university type offered to pupils who are educated or who reside in London. The table shows that the scholarships available in London for giving training of a university type are as follows: open to young men only, 240; open to young men or young women, 120; open to young women only, 40; making a total of 400. These scholarships do not include, however, those that are specially awarded by the City Companies.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xviii. No. 1, January, 1896.—"Sur la réduction à sa forme canonique de la structure d'un groupe de transformations fini et continu," by E. Cartan. This memoir occupies 61 pages. We state the most important results in the writer's own words: "On peut toujours par des

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